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1.	Your Reference	P58809V-GB	
2.	Patent Application number *(The Patent Office will fill in this part)*	26 SEP 2003	0322602.4
3.	Full name, address and postcode of the or each applicant *(underline all surnames)*	The BOC Group plc Chertsey Road Windlesham Surrey GU20 6HJ	
	Patents ADP Number *(if you know it)*		8599821001
	If the applicant is a corporate body, give the country/state of its incorporation	United Kingdom	
4.	Title of the invention	Vent-Run Gas Switching Systems	
5.	Name of your agent *(if you have one)*	FRY HEATH & SPENCE LLP	Andrew Booth The Boc Group plc Chertsey Road Windlesham Surrey
	"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*	The Gables Massetts Road Horley Surrey RH6 7DQ United Kingdom	~~8479554001~~ GU20 6HJ
	Patents ADP Number *(if you know it)*	~~95889273001~~	8599821001

6.	If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or each of these earlier applications and *(if you know it)* the or each application number.	Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*
7.	If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application.		Number of earlier application	Date of filing *(day / month / year)*
8.	Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:* a) *any applicant named in part 3 is not an inventor; or* b) *there is an inventor who is not named as an* c) *applicant, or* d) *any named applicant is a corporate body* *(See note (d))*	Yes		

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Continuation sheets of this form	0
Description	6
Claim(s)	2
Abstract	1
Drawing(s)	1 only

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10. If you are also filing any of the following, state how many against each item.

Priority documents	0
Translations of priority documents	0
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	0
Request for preliminary examination and search *(Patents form 9/77)*	1
Request for substantive examination *(Patents form 10/77)*	0
Any other documents *(please specify)*	0

11. I/We request the grant of a patent on the basis of this application.

Signature Townsend Date 26 September 2003

12. Name and daytime telephone number of person to contact in the United Kingdom: Victoria J Townsend - 01293 776880

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DUPLICATE

VENT-RUN GAS SWITCHING SYSTEMS

This invention relates to vent-run gas switching systems commonly used in atomic layer deposition (ALD) or chemical vapour deposition (CVD) techniques. In particular, the invention relates to an improvement to such systems which reduces the opportunity for cross-reaction between gases in such a system.

Vent-run gas switching systems are commonly used in the growth of multi-layer thin films. Two common example applications are the manufacture of Al_2O_3 and TiN films. In such applications, sources of two or more gaseous species to be deposited are provided, a purge gas source may also be provided. The gases are delivered to a process chamber sequentially, by means of a switching system between the gas sources and the process chamber. Any residual species, purge gas or by-products are exhausted from the process chamber by a pump.

Typically, a purge gas is passed through the reaction chamber between supplies of the species to be deposited. The purpose of the purge gas is to remove any residual (not deposited) species from the process chamber so as to prevent reaction with the next species supplied to the chamber. Were the species allowed to cross react, this might result in impurities and imperfections in the multi-layer film.

In existing vent-run gas switching systems, gases leaving the process chamber enter a common foreline leading to a vacuum pump. Cross reaction of any residual species can occur in the foreline and this can result in the accumulation of particulates in the foreline leading to impaired pump performance. Such impairment of pump performance may compromise the quality of the product manufactured in the process chamber. In addition, the process down time involved in repairing and maintaining affected pumps can increase the costs of manufacture.

The present invention aims to provide a vent-run gas switching system wherein cross reaction of species on exhaust from the process chamber is significantly reduced.

In accordance with the present invention there is provided a vent-run gas switching system comprising:

a plurality of gas supply conduits in fluid communication with a process chamber; a plurality of gas exhaust conduits in fluid communication with the process chamber; a plurality of pumps each in fluid communication with one or more gas exhaust conduits; a first valve system associated with the plurality of gas supply conduits and configured to control supply of a plurality of gases to the process chamber in sequence;

a second valve system associated with the plurality of gas exhaust conduits configured to direct gases exhausted from the process chamber to the pumps, each gas being selectively directable to a pre-selected pump; and

one or more gas supply bypass conduits in fluid communication with one or more of the pumps and bypassing the process chamber.

Optionally, the system further includes a controller for controlling the operation of the first and second valve systems, in use, to supply gases to the process chamber in a pre-selected sequence and exhaust gases, in sequence, to pre-selected pumps.

In addition to controlling the sequence in which valves are opened and closed, the controller may be configured to control the duration for which any given valve is opened and the extent to which any given valve is opened. In the latter case, adjustment of the valve may be used to control the duration, pressure and/or volume of a given gas supplied to the process chamber thereby controlling the quantity of gaseous species delivered in a given time. Furthermore, the controller may be configured

to allow a predetermined delay between opening of valves respectively in the first and second valve systems to ensure all gas in an exhaust conduit has been exhausted before new gas is introduced.

The respective pluralities of gas supply conduits, gas exhaust conduits and pumps need not be the same. For example, there may be more gas supply conduits than gas exhaust conduits or pumps, more than one gas being selectively exhausted to the same pump.

The system may further comprise a plurality of gas filled containers connected in fluid communication with the gas supply conduits. Optionally, at least one of the gas filled containers may be filled with a purge gas.

For the purposes of exemplification, an embodiment of the invention will now be further described with reference to the Figures, in which;

Figure 1 illustrates a vent-run gas switching system in accordance with the prior art.

Figure 2 illustrates a vent-run gas switching system in accordance with the present invention.

As can be seen from Figure 1 a prior art vent-run gas switching system comprises two gas supplies Gas A and Gas B each connected to a process chamber 11 and pump 12 by means of a series of conduits 13-18. The conduits 13 to 16 include valves which can be operated to control the flow of Gas A and Gas B to the pump 12 via the process chamber 11, or bypassing 17 the process chamber 11. Thus, only one of the gases is supplied to the chamber at any one time.

To supply Gas A to the chamber 11; valved conduit 14 is opened , Gas A flows directly through valved conduit 14 into the chamber 11 and

exhausts through conduit 18 to pump 12. During delivery of Gas A, valved conduits 15 and 16 remain closed whilst valved conduit 13 is open. Gas B therefore flows through conduits 13, 17 and 18 to the pump 12 bypassing the chamber. To supply Gas B to the chamber 11, valved conduits 15 and 16 are opened and valved conduits 13 and 14 are closed. In this configuration, Gas B is supplied through conduit 15 to the chamber 11 and exhausted via conduit 18 to the pump 12. Meanwhile, Gas A is supplied through conduits 16, 17 and 18 directly to the pump 12, bypassing 17 the chamber 11.

It will be appreciated that, as both gases pass through conduit 18 and exhaust to the single pump 12, there is scope for cross reaction between residuals of each gas remaining after switching between the gas supplies.

Figure 2 illustrates a vent-run gas switching system in accordance with the present invention.

As can be seen from Figure 2 a vent-run gas switching system comprises three gas supplies Gas 1, Gas 2 and Gas 3. Typically, Gas 1 may be a purge gas and Gas 2 and Gas 3 process gases to be reacted in the process chamber 4 for example, to form a multi-layer conductor semi-conductor product, or an multi-layered insulator. Each gas supply is connected to the process chamber 4 and one of two pumps 7, 8 by means of conduits 21, 22, ...35. The conduits 25 to 35 include valves which can be operated to control the flow of Gases 1, 2 and 3 to the pumps 7 and 8 via the process chamber 4, or bypassing 21 the process chamber 4.

When valved conduits 25, 26, 27 and 28 are closed and 31 to 35 opened, Gas 2 is supplied directly to the process chamber 4 and exhausted to pump 7. Meanwhile, Gas 1 (a purge gas) is directed to pump 7 through conduits 31 and 21a and b and Gas 3 is directed to pump 8

through conduits 23a and b, 33 and 35. As Gas 1 is an inert purge gas, it can safely be mixed with Gas 2 at the foreline of pump 7 as no cross reaction of the gases will occur. Following a supply of Gas 2, the chamber may be purged by a supply of purge gas, Gas 1. This purge is achieved by closing conduits 31 and 32 and opening conduits 25 and 26. Conduits 27 and 28 remain closed as do conduits 29 and 30. Purge gas, Gas 1 is directed through conduits 21a and b and 25 into the process chamber 4 and exhausts to pump 7 through conduits 24 and 34. Gas 2 is directed through conduits 22 and 26 and conduit 21b to the pump 7, bypassing the process chamber 4. Meanwhile Gas 3, continues to pass directly through conduits 23a and b, 33 and 35 to pump 8, bypassing the process chamber 4. Thus the chamber 4 is purged of Gas 2 and Gas 3 can safely be introduced.

Gas 3 is introduced by opening valved conduits 27, 28, 29 and 30. Valved conduits 25, 26, 33, 34 and 35 are closed. Gas 3 is directed through conduits 23a and 28 to process chamber 4 and exhausted to pump 8 via conduits 24 and 29. Gas 2 is directed to pump 7 through conduits 22, 27, 23b and 30 bypassing the process chamber 4. Gas 1 is directed to pump 7 through conduits 31 and 21a and b, bypassing the process chamber 4.

Thus it can be seen, by suitable operation of the valved conduits 25 to 35, each of the three gases Gas 1, Gas 2, Gas 3 can be sequentially supplied to the process chamber 4 whilst the reactive gases 2 and 3 can be fed to separate pumps 7 and 8. As the gases Gas 2 and Gas 3 are diverted to a given pump 7,8 before they reach the pump foreline, there is no opportunity for cross reaction and consequent particulate contamination of the pumps.

It will be appreciated that the described arrangement can easily be extended for more than two reactive gases by adding further valved conduit arrangements and pumps in parallel. It will further be appreciated

that separate pumps are only needed where any given two or more gases will cross react with each other. Any two or more gases which will not cross react, can safely be directed to a single pump using the arrangements of the invention.

The foregoing description is purely exemplary of just one embodiment of the invention and is not intended to be restrictive of the true scope of the invention as claimed in the appended claims.

CLAIMS

1. A vent-run gas switching system comprising:

a plurality of gas supply conduits in fluid communication with a process chamber; a plurality of gas exhaust conduits in fluid communication with the process chamber; a plurality of pumps each in fluid communication with one or more gas exhaust conduits; a first valve system associated with the plurality of gas supply conduits and configured to control supply of a plurality of gases to the process chamber in sequence;

a second valve system associated with the plurality of gas exhaust conduits configured to direct gases exhausted from the process chamber to the pumps, each gas being selectively directable to a pre-selected pump; and

one or more gas supply bypass conduits in fluid communication with one or more of the pumps and bypassing the process chamber.

2. A vent-run gas switching system as claimed in claim 1 further comprising a controller for controlling the operation of the first and second valve systems, in use, to supply gases to the process chamber in a pre-selected sequence and exhaust gases, in sequence, to pre-selected pumps.

3. A vent-run gas switching system as claimed in claim 2 wherein the controller is configured to control the duration for which any given valve in the first or second valve system is opened and the extent to which any given valve in the first or second valve system is opened.

4. A vent-run gas switching system as claimed in claim 2 or claim 3 wherein the controller is configured to allow a predetermined delay between opening of valves respectively in the first and second valve

systems to ensure all gas in an exhaust conduit has been exhausted before new gas is introduced.

5. A vent-run gas switching system as claimed in any preceding claim further comprising a plurality of gas filled containers connected in fluid communication with the gas supply conduits.

6. A vent-run gas switching system as claimed in claim 5 wherein at least one of the gas filled containers is filled with a purge gas.

7. A vent-run gas switching system as claimed in any preceding claim wherein the respective pluralities of gas supply conduits and/or gas exhaust conduits and/or pumps differ.

8. A vent-run gas switching system substantially as described herein and with reference to Figure 2.

ABSTRACT

VENT-RUN GAS SWITCHING SYSTEMS

A vent-run gas switching system comprising:

a plurality of gas supply conduits 22, 23, 25, 28, 32, in fluid communication with a process chamber 4; a plurality of gas exhaust conduits 24, 34, 29, in fluid communication with the process chamber 4; a plurality of pumps 7, 8 each in fluid communication with one or more gas exhaust conduits; a first valve system 31, 32, 33, 25, 26, 27, 28 associated with the plurality of gas supply conduits and configured to control supply of a plurality of gases 1, 2, 3 to the process chamber 4 in sequence;

a second valve system 34, 35, 29, 30 associated with the plurality of gas exhaust conduits configured to direct gases 1, 2, 3 exhausted from the process chamber 4 to the pumps 7, 8, each gas being selectively directable to a pre-selected pump; and

one or more gas supply bypass conduits 21b, 23b in fluid communication with one or more of the pumps 7, 8 and bypassing the process chamber 4.

(Fig. 2)

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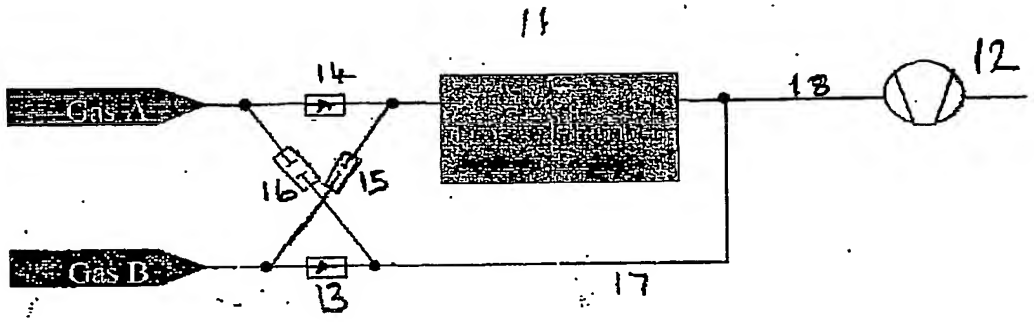
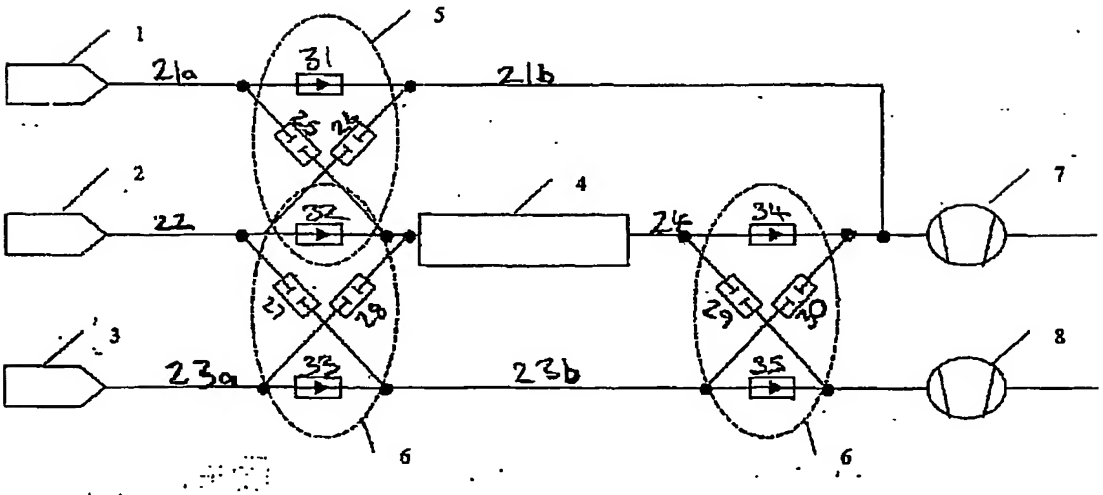

11
12
14
Gas A
18
16
15
Gas B
13
17

FIG 1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21a
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23a
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23b
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FIG. 2

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